NLRI AppMetaData Path Attribute for 5G Edge Computing Service

draft-dunbar-idr-5g-edge-compute-app-meta-data-01

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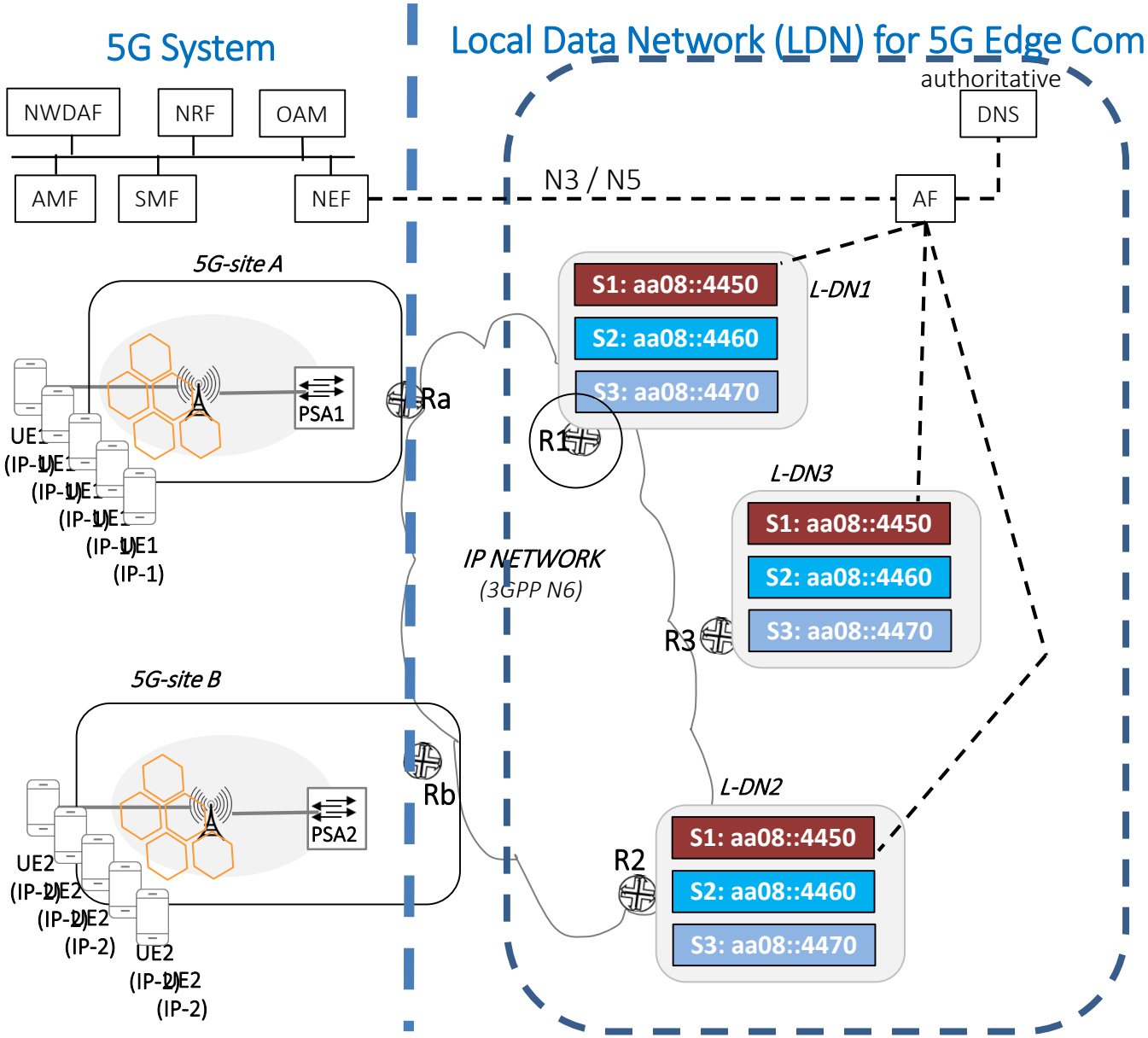
Intention of the draft

- Purpose:
  - a new BGP Network Layer Reachability Information (BGP NLRI) Path Attribute: AppMetaData,
    - To distribute the 5G Edge Computing App running status and environment,
    - For other routers in the 5G Local Data Network to make intelligent decision on optimized forwarding of flows from UEs.
    - The goal is to improve latency and performance for 5G Edge Computing services.
  - We would like to hear your feedback.

5G Edge Computing (3GPP TR23.748)

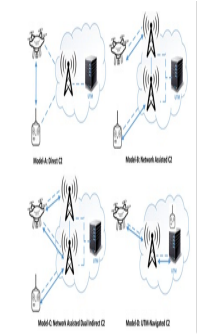


One Application has multiple Application Servers located in Edge Computing DCs

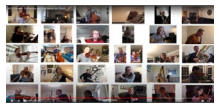
Use Cases

- Unmanned Aerial Vehicles (Drones) <-> Controller, Traffic Management, and App Servers

  13 detailed use cases described in 3GPP TR22.829



- Virtual concert

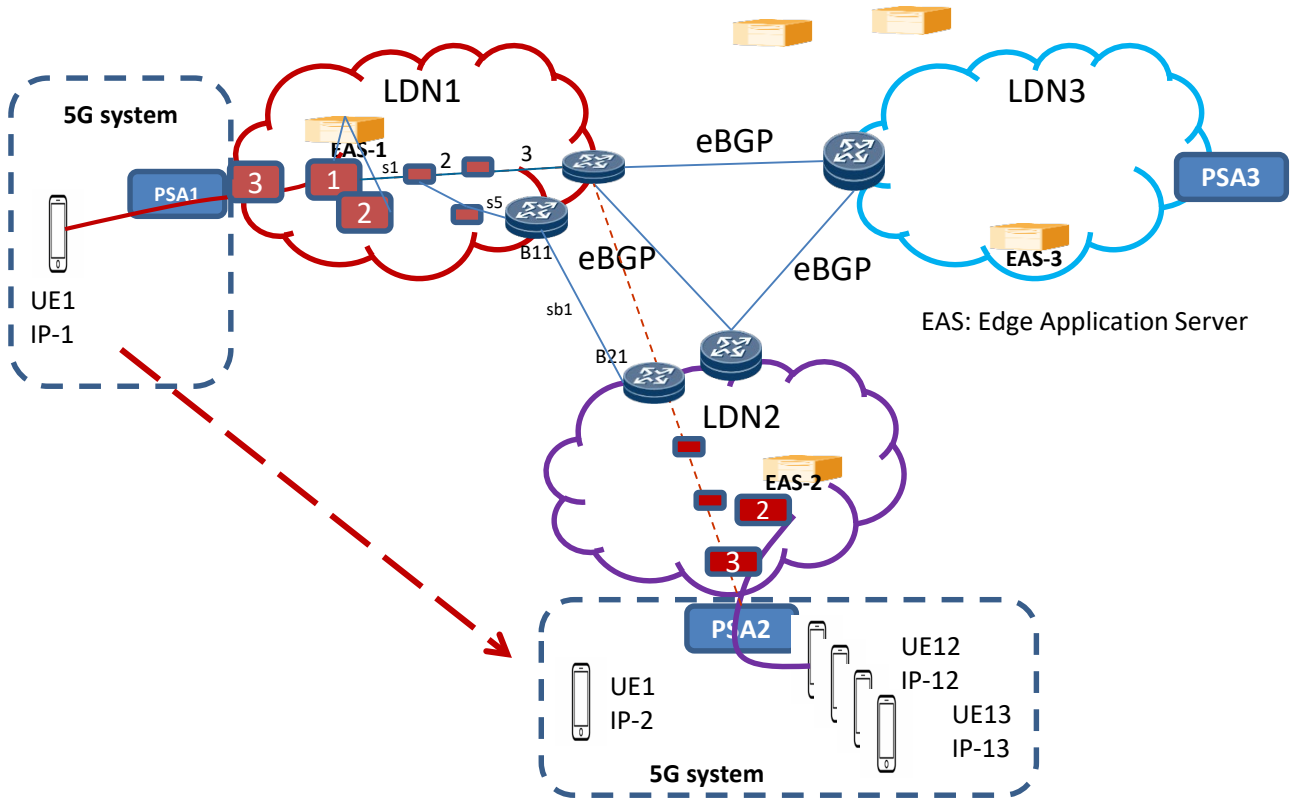


- Virtual Interactive Conference
  - Computing (e.g. the encoding, video stitching, compressing, etc.) can be processed by the server in the edge.

From IP Network Perspective…

ANYCAST: IP Layer Application ID -> multiple App servers
Benefit of using ANYCAST:

- ✓ **dynamically load balance across locations based on network conditions.**
- ✓ **leverages the proximity information present in the network (routing) layer and**
- ✓ **eliminates the single point of failure and bottleneck at the DNS resolvers and application layer load balancers.**
- ✓ **removes the dependency on UEs using their cached destination IP addresses for extended period**



Problem 1: Selecting 5G Edge Application Location

- ➢ Many mini data centers can be close in proximity, making it difficult to differentiate in Routing Hops for App servers hosted in them,
- ➢ Some data centers can have higher capacity than others,
- ➢ Some sites may be more preferred when a UE anchored to a new 5G Site

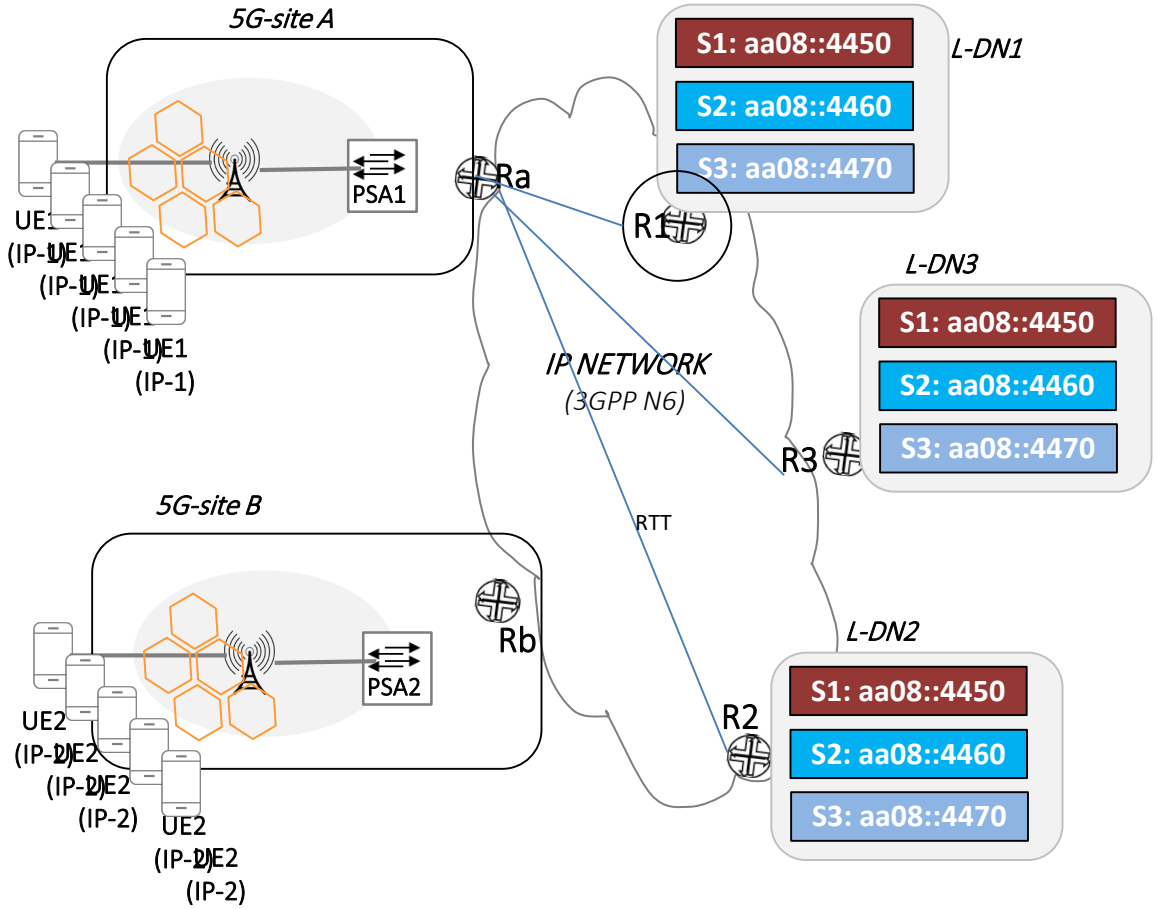
Problem #2: sticking to original App Server

Problem #3: Application Server Relocation

Factors in selecting ANYCAST Server in 5G EC

- RTT to “app.net” ANYCAST S1:
  - List of {
    - R1: RTT value
    - R2: RTT value
    - R3: RTT value

    }
- Capacity
- Site Preference



Solution : a new BGP NLRI Path Attribute: AppMetaData

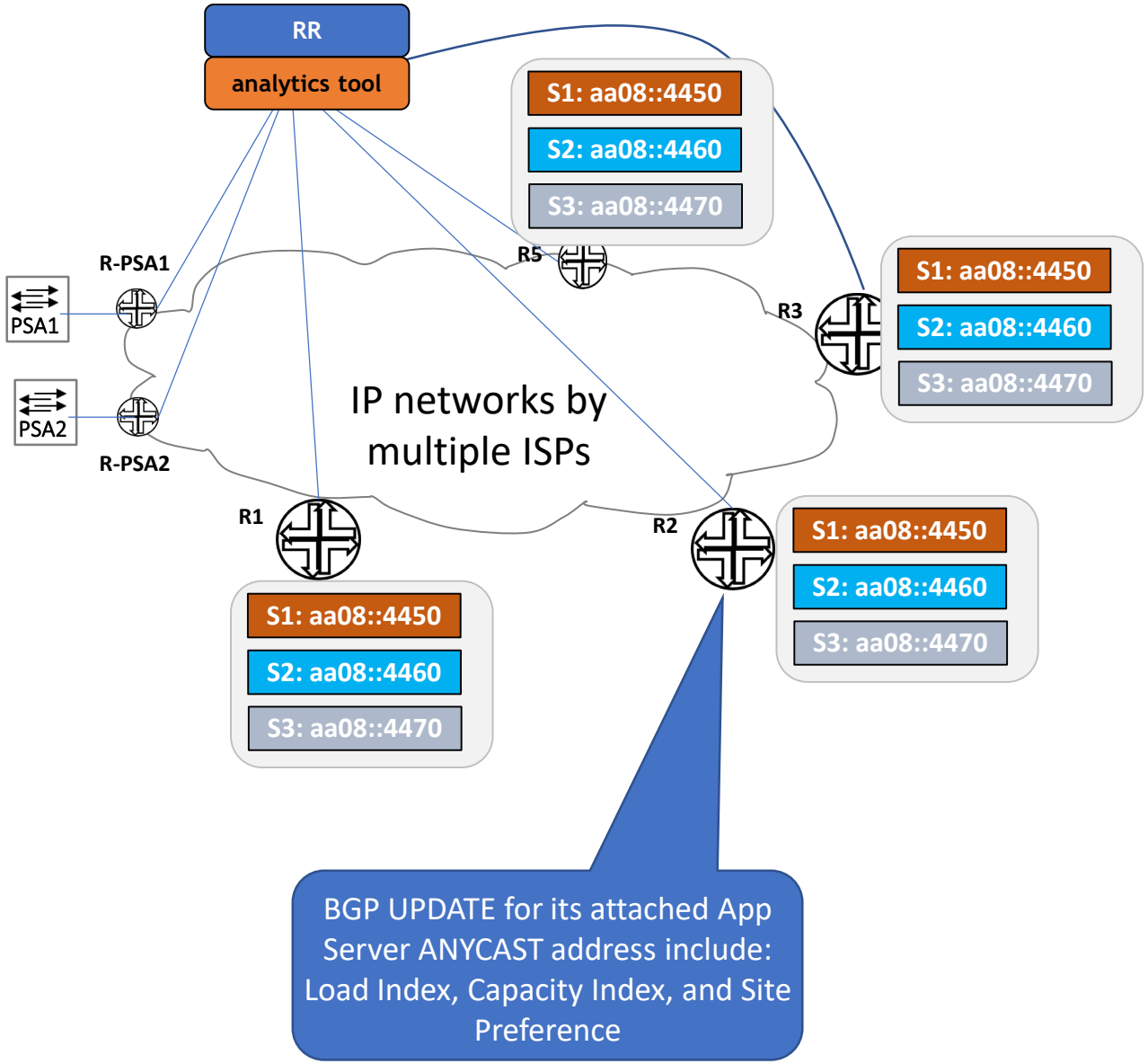
NLRI BGP UPDATE:

Client route= S1: aa08::4450

AppMetaData TLV

- Load Measurement subTLV
- Capacity Index subTLV
- Site Preference subTLV

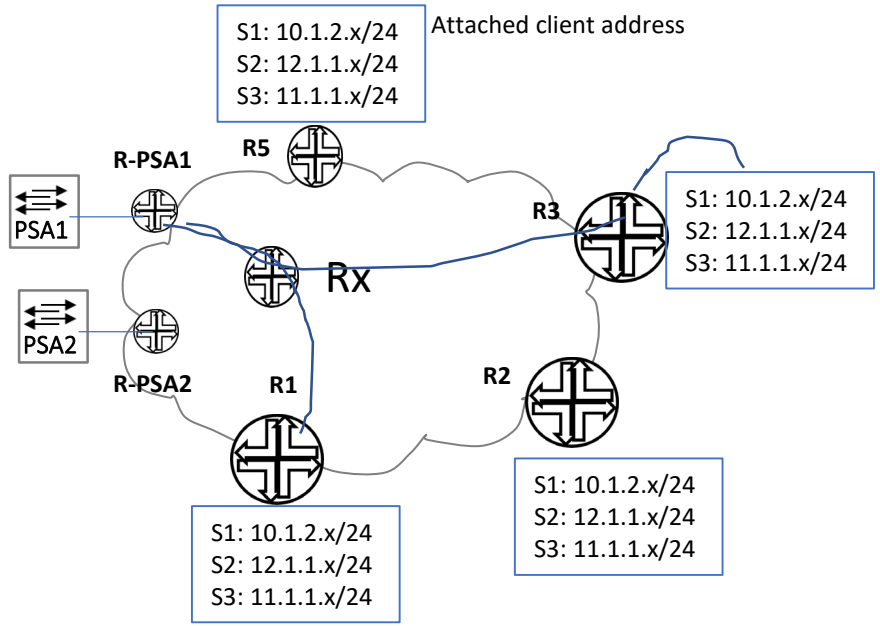
Potentially to include Sub-TLVs for
https://datatracker.ietf.org/doc/draft-mcd-rtgwg-extension-tn-aware-mobility/



Load Measurement Sub-TLVs

```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Type (TBD2)           |                Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Measurement Period                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            total number of packets to the App Server           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            total number of packets from the App Server         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            total number of bytes to the App Server             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            total number of bytes from the App Server           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Type (TBD3)           |                Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Measurement Period                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Aggregated Load Index to reach the App Server       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```



Load measurement SubTLV:

Type= TBD2: measurements of packets/bytes to/from the App Server address;

Type =TBD3: Load Measurement Index

Measure Period: BGP Update period or user specified period

Load Measurement Index: Weighted combination of bytes/packets sent to/received from the App server:

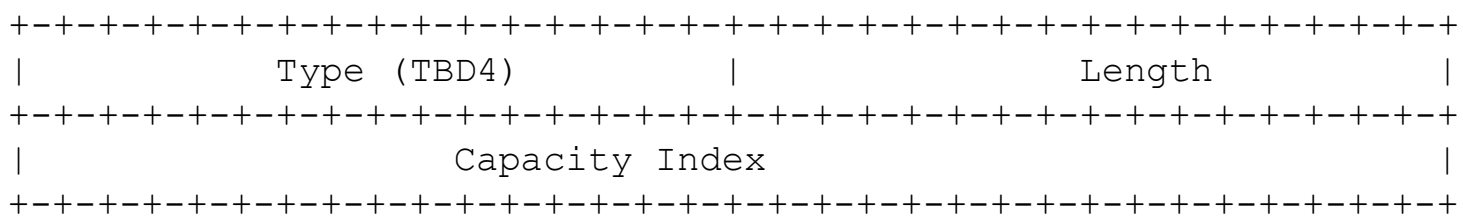
Load Measurement Index = w1 * ToPackets + w2* FromPackes + w3*ToBytes + w4*FromBytes

w1+ w2+ w3+ w4 = 1 & 0< =wi <=1;

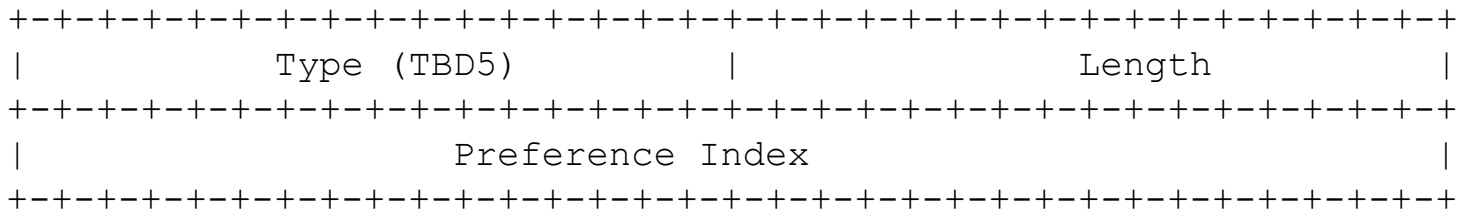
Capacity Index and Site Preference Index

Capacity Index can also be derived from historic data.

Type =TBD4: capacity Index subTLV;



Type =TBD5: Site preference Index subTLV;

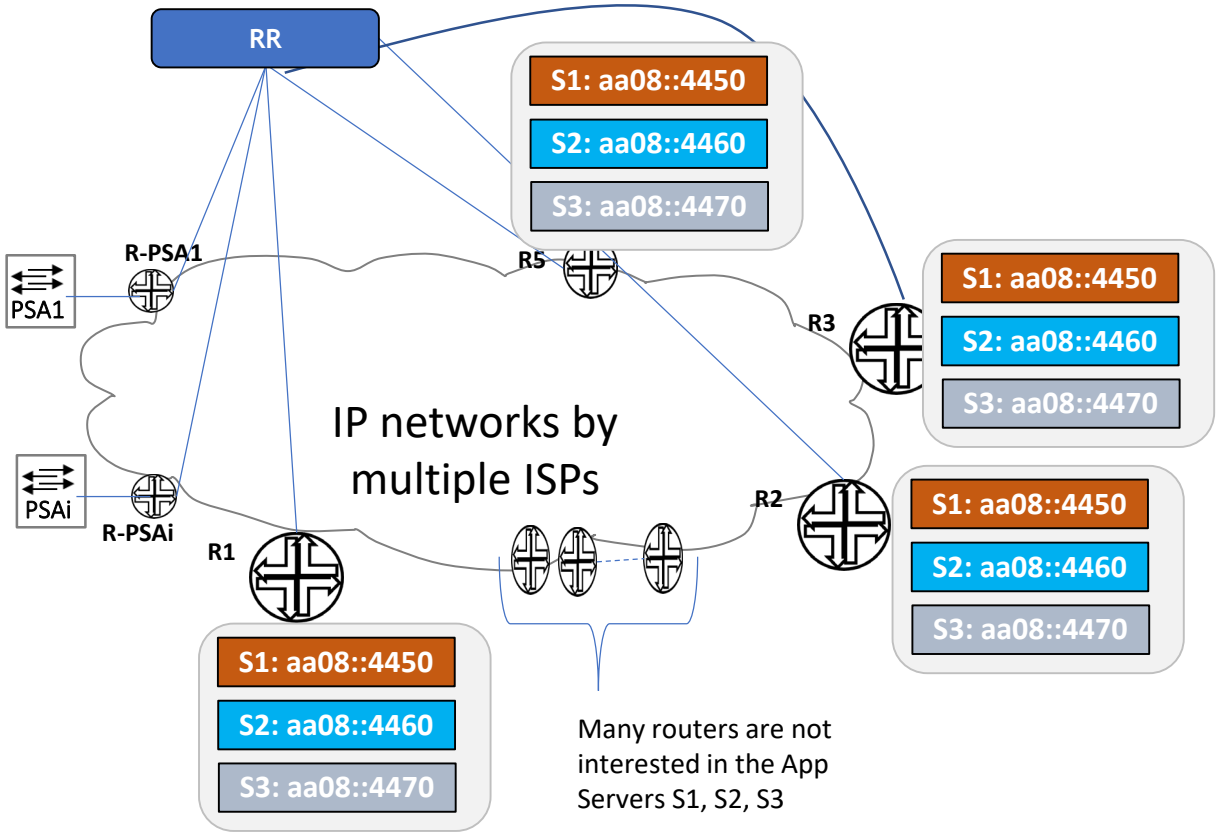


Capacity index : larger value means higher capacity, 1-10. if absent, use default value 5.
Site preference Index, which is also the network preference index: larger value means higher preference: 1-10. If absent, use default value 5.

AppMetaData Propagation Scope

- BGP RT constrained distribution (RFC4684)
  - there are much more App Servers than the number of routers
- Create a AppServer-Bound-Group
  - Static configuration
  - each ingress router to ask a network controller upon receiving the first packet to a specific ANYCAST address to be included in the "Application Bound Group Routers"

AppServer ID	Interested Routers	Time To Live	Other attributes
S1: aa08::4450	R-PSA1, R-PSA2		
S2: aa08::4460	R-PSA1,		



Soft Anchoring of an ANYCAST flow

Using a group of ANYCAST addresses to achieve the Soft Anchoring a flow to one ANYCAST Location

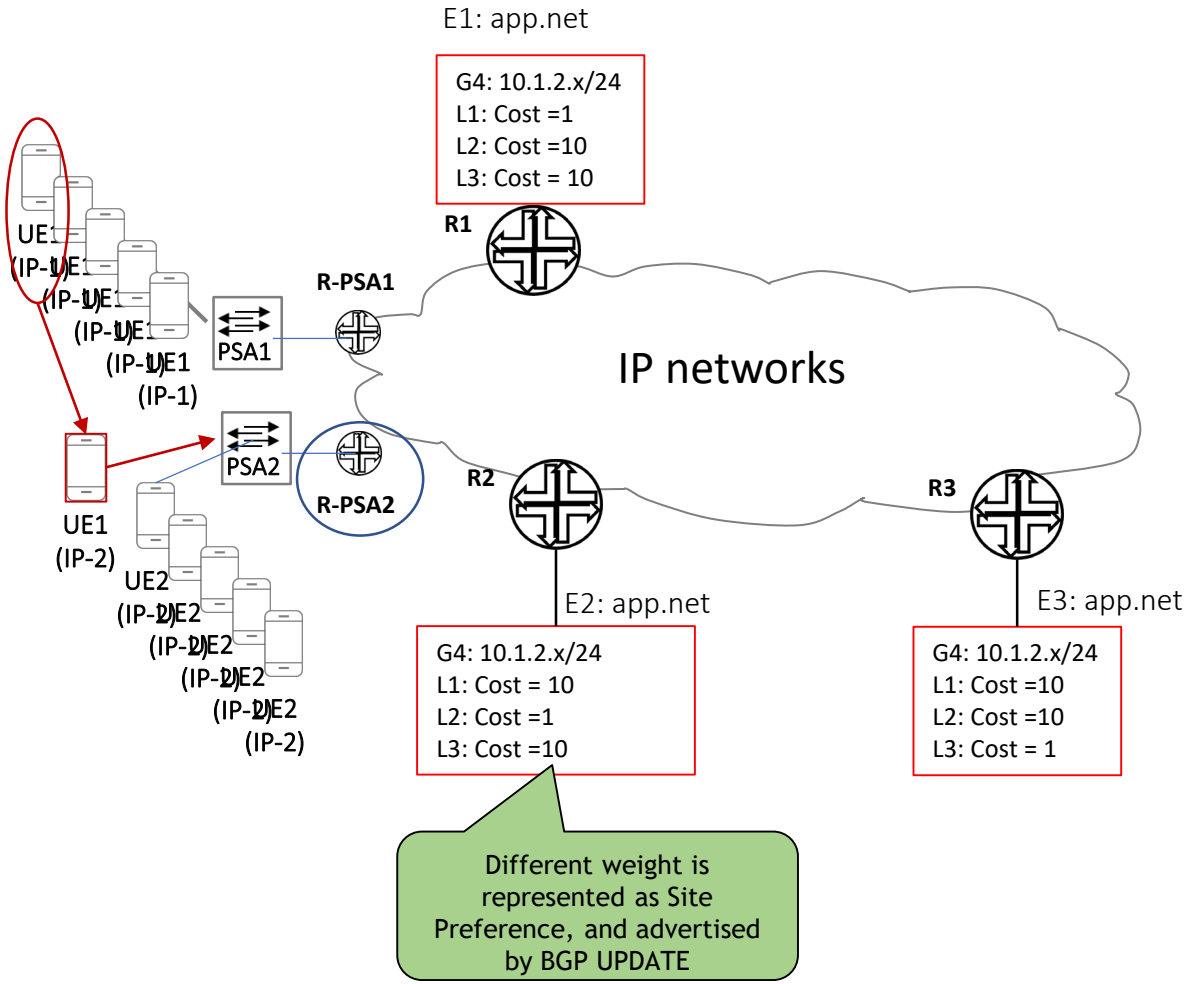
TABLE 1: DNS configuration:

```
// global FQDN: app.net
app.net      172800  IN  A          G-4
app.net      172800  IN  AAAA       G-6

// FQDN: op1.app.net
ldn1.op1.app.net        172800  IN  A          L1
ldn2.op1.app.net        172800  IN  A          L2
ldn3.op1.app.net        172800  IN  A          L3
```

IP ROUTES 2: Route Injection from AF -> IP Controller:

```
G-4 -> {E1, E2, E3}
L1 -> E1 | {E2, E3} if E1 has failed
L2 -> E2 | {E1, E3} if E2 has failed
L3 -> E3 | {E1, E2} if E3 has failed
```



Background Information

Algorithm in Selecting the Optimal Target Location

To compare the cost to reach the Application Server between the Site-i or Site-j:

$$Cost\text{-}i = \min\left(w * \frac{Load\text{-}i * CP\text{-}j}{Load\text{-}j * CP\text{-}i} + (1-w) * \frac{Pref\text{-}j * Delay\text{-}i}{Pref\text{-}i * Delay\text{-}j}\right)$$

- Load-i: Load Index at Site-I = w1*ToPackets+w2*FromPackes+w3*ToBytes+w4*FromBytes

  0<= wi <=1 and w1+ w2+ w3+ w4 = 1.
- CP-i (Capacity-i) (higher value means higher capacity): capacity index at the site i.
- Delay-i: Network latency measurement (RTT) to the A-ER that has the Application Server attached at the site-i.
- Pref-i (Preference Index: higher value means higher preference): Network Preference index for the site-I.
- w: Weight for load and site information,
  - 0<= w <=1: If smaller than 0.5, Network latency and the site Preference have more influence; otherwise, Server load and its capacity have more influence.